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ABSTRACT

This module is the sixth in a series of eleven modules in an energy conservation curriculum for secondary and postsecondary vocational students. It is designed for use by itself or as part of a sequence of four modules on understanding utilities (see also modules 3, 5, and 7). The objective of this module is to train students in the recognition, implementation, and utilization of energy consumption and possible conservation in residential hot water heating and domestic hot water use. First, an introduction to the module and definitions of key terms are provided. Next, the text is presented in the following three units: (1) domestic hot water use; (2) water conservation; and (3) consider solar water heating. The information in each unit is presented in lecture format accompanied by laboratory exercises and questions/examples for class discussion. A bibliography and several charts illustrating the text material are found at the end of the module. (BM)

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Energy Conservation Curriculum for Secondary and Post-Secondary Vocational Students. Module 6.

HOT WATER HEATING CONSERVATION OPPORTUNITIES

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NAVARRO COLLEGE
CORSICANA, TEXAS

April, 1979

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
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MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

This module is one of a group of 11 modules in an energy conservation curriculum for secondary and post-secondary vocational students. Hot Water Heating Conservation Opportunities may be offered by itself or as a part of a sequence of three modules in the following order:

Order	Module	Title of Module
1	3	Understanding Utility Bills
2	6	Hot Water Heating Conservation Opportunities
3	7	Appliance Energy Conservation Opportunities

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MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

MODULE DESCRIPTION:

The types of hot water heaters are discussed and compared to ascertain the operating characteristics and the efficiency of each from the standpoint of input energy, heat loss, and recovery capacity. Hot water temperature variances for specific household uses are discussed for appliances such as dishwashers and clothes washers. Personal hygiene in using showers versus baths, water use habits for shaving, rinsing items, and related activities are discussed for various family sizes. Water use and control for food preparation and kitchen use are outlined. Flow rates for water consumption are explained and costs versus benefit analysis in hot water conservation opportunities are surveyed.

In addition to hot water use, water use and water conservation activities for cold water are discussed as indirect and direct energy users in the home and at the power plant. Finally, solar water heating is discussed as a potential alternative to using conventional energy to heat water in the home.

GOAL STATEMENT:

The objective of this module is to train secondary and post-secondary students in the recognition, implementation, and utilization of energy consumption and possible conservation in residential hot water heating and domestic hot water use.

UNITS:

1. Domestic Hot Water Use
   - A. Hot Water Heaters
   - B. Energy Saving Tips for Hot Water Use
     - 1.) General
     - 2.) Personal Hygiene
     - 3.) Kitchen and Laundry

2. Water Conservation
3. Consider Solar Water Heating
   - A. Solar Energy Systems
   - B. Kinds of Systems
   - C. The Final Decision

MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

TERMINOLOGY

auxiliary heater - a conventional hot water heater that acts as a back-up to bring the water up to temperature on cloudy days. It is used in support of a solar water heating system.

closed loop system - a solar energy system which circulates a liquid continuously between a collector and a storage tank utilizing a heat exchanger and a treated water solution.

flue - a tube that allows gases formed during the burning process to escape.

grey water - recirculated, non-potable water.

heat exchanger - also called a heat chamber. The part of the furnace or solar energy system that houses the burners or the heating elements. Air or water is warmed as it passes through the heat exchanger.

insulation - material that does not readily conduct heat energy.

kilowatt-hour - a unit of power equal to 1000 watts; equals about 3,400 Btu's.

open-loop system - a solar energy system which heats water through the collector and circulators it through a storage tank.

potable water - water that is suitable for drinking.

solar energy - pertaining to the heating property of the sun.

thermosyphon - a solar water heating system which circulates water from the collector to the storage tank by hot water rising, being pushed by the cold water, thus creating a circulation.

volt - unit of electrical potential difference and electromotive force equal to the difference of potential between two points in a conducting wire carrying a constant current of one ampere when the power dissipated between these two points is equal to one watt and equivalent to the potential difference across a resistance of one ohm when one ampere is flowing through it.

watt - unit of power equal to the rate of work represented by a current of one ampere under a pressure of one volt and taken as the standard in the U.S.: 1/746 horsepower.

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MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

UNIT 1

DOMESTIC HOT WATER USE

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Appreciate and discuss the substantial amount of energy required to supply hot water for domestic use.

2. Recognize the characteristics and operational features of various electric and gas water heaters.

3. Discuss the reasons for and compute the operational cost differences between gas and electric water heaters.

4. Discuss routine maintenance steps the customer can perform to increase the efficiency of the home water heater.

5. Formulate a philosophy of energy conservation in using hot water for personal hygiene, kitchen, and laundry use.

LECTURE

INTRODUCTION

Water has been considered a free resource with unlimited supply and availability in our country. This attitude, however, is changing somewhat. Environmental considerations now restrict the building of dams, water reserves, and sewage plants. Population is shifting more to the Sunbelt states where water can be relatively scarce.

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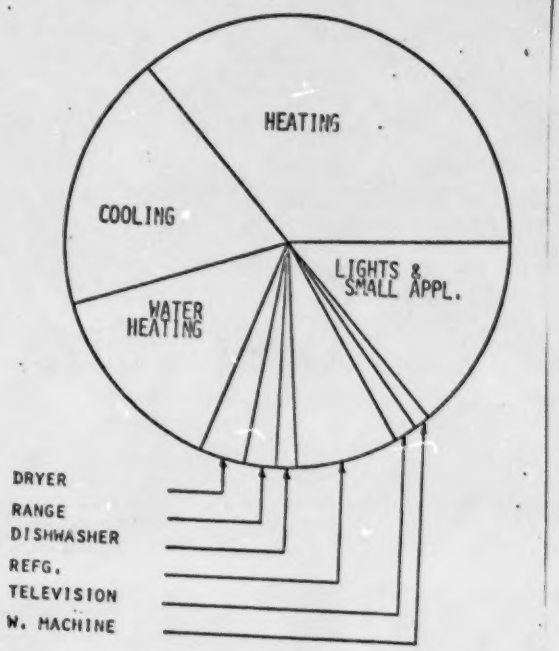
This requires new water supplies as well as energy to treat the water before using, to treat the sewage after using, and to pump and transport water for servicing homes and businesses. Therefore, water used in the home represents the expenditure of considerable energy, either directly or indirectly, and should be used conservatively.

The most direct expenditure of energy in water use is for heating water. If a person conserves household water, there will be a small savings realized on the monthly water bill; but if a customer uses less hot water, there can be a substantial savings on the gas or electric bill.

Energy used to heat water for domestic use is the second largest household use of gas, electricity, and oil following space heating and cooling requirements. The cost of heating water constitutes approximately 25% of the annual home energy bill. (Figure 1.1) Conservation measures can be taken without sacrificing domestic comfort or convenience, and at minimal expense. This module will explore the conservation opportunities for using hot water in the home and the benefits gained from them. It will conclude by discussing general water saving measures related to cold water use.

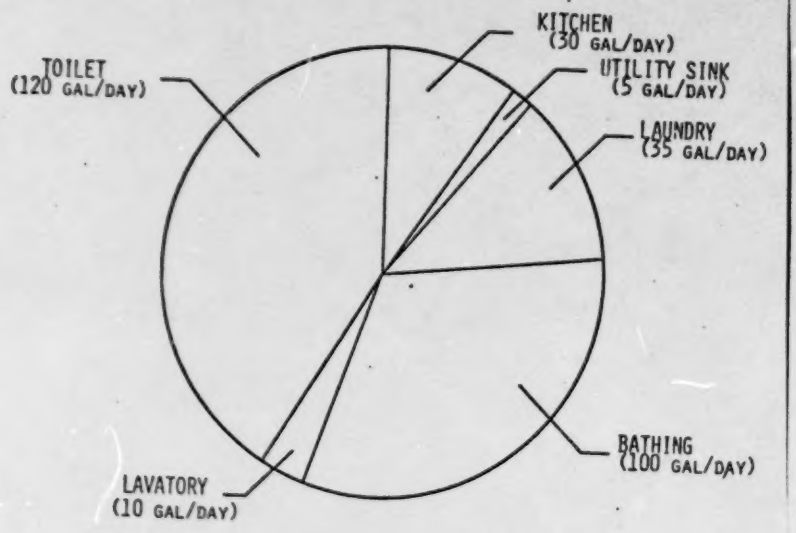
FIGURE 1.1
AVERAGE ANNUAL KWH BY APPLIANCE



SOURCE: Texas Power and Light Company

The average American family of four uses approximately 300 gallons of water a day for indoor use. Figure 1.2 breaks down this water consumption as follows: toilets consume 40%; lavatories, 3%; bathing, 33%; laundry, 12%; utility sink, 2%; and kitchen, 10%.

FIGURE 1.2
WATER CONSUMPTION IN A TYPICAL HOME (FAMILY OF FOUR)



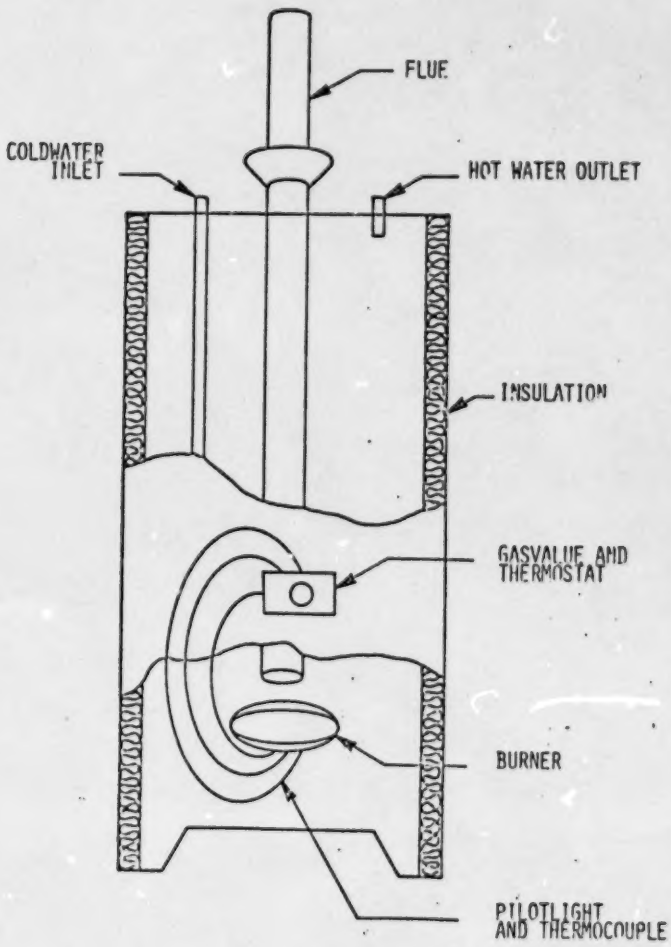
Of this daily amount, about 75 gallons is hot water. Therefore, of the 110,000 gallons of water used annually, 27,500 gallons are hot water, which requires 23 to 41 million BTU's of energy to heat. This amounts to 180 gallons of oil or 6,000 KWH of electricity annually at a cost to the customer of about $120 for oil or gas and over $200 for electricity. This cost is above the cost for the water itself which can be $75 to $100 annually. The actual water consumption for the home varies widely, depending on living habits of the users and the efficiency of the fixtures and appliances. To save energy and cut down on hot water costs, consider the hot water tank in terms of its size, and location.

A. HOT WATER HEATERS

The domestic hot water heater is the source for supplying heated water in the home. Gas water heaters and electric water heaters operate much like a gas or electric furnace. If checked periodically and maintained properly they will operate efficiently, giving the customer the most hot water for energy spent.

The gas water heater is a tank of various gallon capacities with insulated sides and a flue through the center of the unit vented to the outside as shown in Figure 1.3.

FIGURE 1.3
THE GAS WATER HEATER



It is heated by a circular burner located at the bottom of the tank. The gas valve and thermostat are usually combined in one assembly and located on the front outside of the tank. This allows gas to be fed to the burner and shut off once the water has reached a certain temperature. There is a thermocouple as a safety device which shuts off the gas valve if the pilot light should go out. The tank is often glass lined and retains heat similar to a thermos bottle. The amount of insulation varies from 1 1/2 inches to about 3 inches. Becoming acquainted with these features and paying close attention to their proper operation helps dispel the mystery and helplessness some people have if something goes wrong with their hot water heater.

The consumer should periodically check the tank for cracks, leaks, and proper gas, water, and flue/pipe connections. Any means by which heat or hot water can escape constitutes a waste of energy. Check the burners for cracks or breaks and clean them for proper burning. Make sure the flue is free from obstructions and have a rain cap. Birds often build nests in warm flues which are not capped. Once a month, flush the tank to rid chemical impurity build-up and rust. Clean dust and grease build-up from the thermostat and valve housing and connecting wires. Additional measures will be discussed later in this module.

The construction of electric water heaters, unlike gas heaters, vary depending on the type and placement of the heating elements. The heating elements of electric heaters may be

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wrapped around the tank or submerged within, may have one heating element or two elements, and may require 120 volts or 240 volts for operation. The volume size of an electric water heater must be larger than a gas heater for comparable service. For instance, the average gas hot water tank size for a family of four is 30 gallons. The required size of an electric hot water heater for the same family is 50 gallons. The reason for this is that an electric water heater cannot heat water as quickly as gas and therefore, requires a larger initial heated volume.

There are advantages to an electric water heater, however. It can be completely surrounded by insulation instead of insulating only the sides of a gas heater. An electric unit requires no flue pipe enabling it to be placed anywhere in the home. Operating costs, however, are much greater for an electric hot water heater than for its gas counterpart.

Most electric water heaters use 240 volts, with only the smaller ones using 120 volts. Dual heating element models provide more hot water than single element ones but cost more in initial price and operating costs. In a dual element model, the main heating element is located near the bottom of the water heater where cold water enters the unit. As hot water is drawn from the tank, cold water enters the bottom of the tank and activates the bottom heating element as shown in Figure 1.4.

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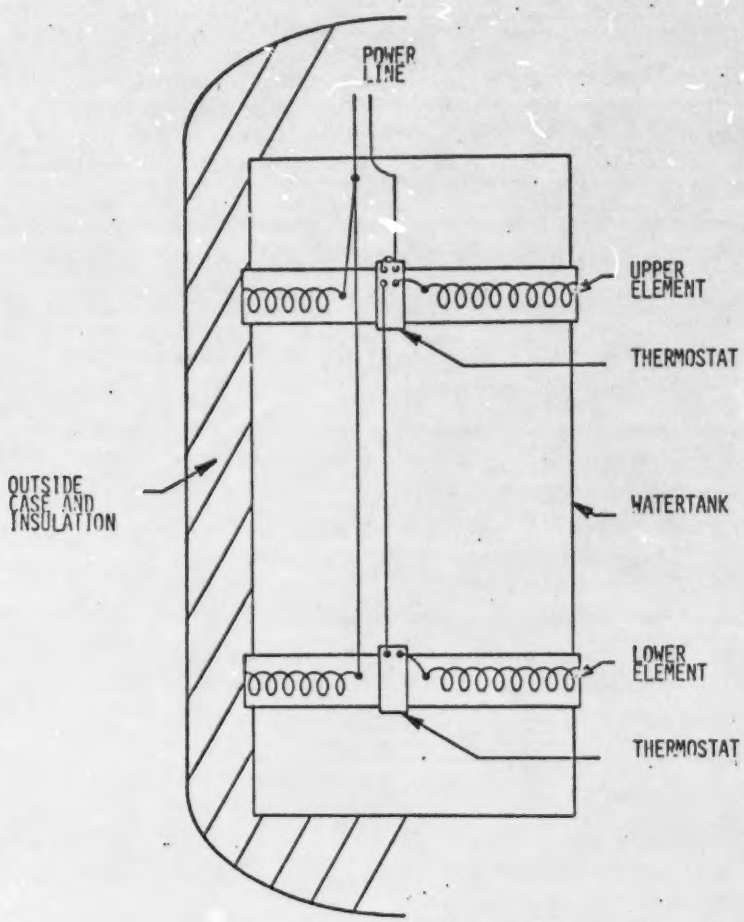
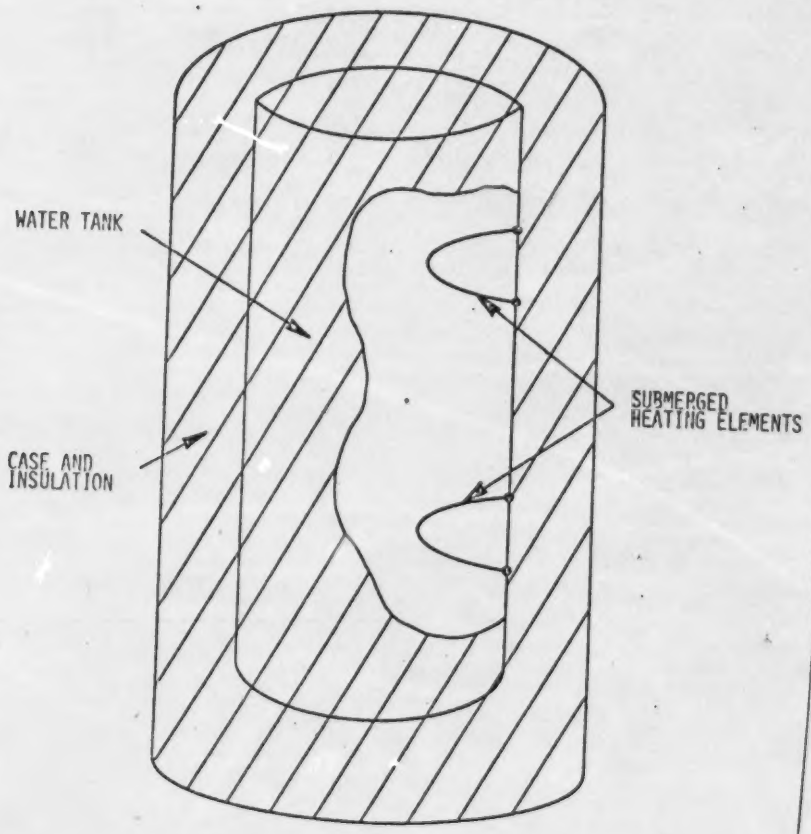
FIGURE 1.4 THE BELTED-ELEMENT ELECTRIC WATER HEATER



For normal use this is the only heating element needed to heat the water. If there is a great demand the upper element as well as the bottom element will heat. The heating elements in Figure 1.4 are belted types which wrap around the outside of the tank. The insulation and outside casing cover the heating

belts. Figure 1.5 shows an electric hot water heater which uses two submersible heating elements. The principle is the same as with the belted heating elements in Figure 1.4

FIGURE 1.5 THE SUBMERSIBLE-ELEMENT WATER HEATER



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Each of the two elements has its own thermostat to control the temperature of the water. The top element heats first and remains on until the present temperature is reached by the top thermostat. The top thermostat then turns off its heating element and turns on the bottom element. Each of the two elements may be the same wattage rating or may differ, such as 4500 watts for the bottom element and 2500 watts for the top element. Quick-recovery water heaters have higher wattage ratings than regular models, use more energy, and require heavier gauge wire to operate.

Routine maintenance is important on an electric hot water heater because cracks in the outer case can allow water to come in contact with the heating element. This provides a path for electricity to ground which causes an unnecessary drain on the electricity.

In addition to routine maintenance of hot water heaters, there are other measures one can take to increase the efficiency of the water heater itself. In a typical household, heat loss through the tank walls account for approximately 25% of the energy consumed for heating the water. Additional losses occur through uninsulated service pipes. The burners and heating elements in the tank account for a great loss in efficiency since a gas or oil burner is only 50-60% efficient in its configuration and an electric heating element is only 33-40% efficient.

To help cut down on these heating losses, consider wrapping the water tank with a 2-3 inch batt of insulation.

Place the insulation with the vapor barrier away from the tank. On an electric heater, cover the top as well as the sides and secure it with duct tape. On a gas or oil heater the top cannot be covered because of water connections and the flue. There are also hot water blanket kits available from hardware and major catalog order stores for $20 to $25. This can cut heat loss and save about 400 KHW/year for electric heaters and about 3600 CCF gas/year.

Hot water service pipes should be wrapped with 1/2 inch foam or fiberglass insulation. This is easy in new construction but may be impractical in a standing structure. These two steps, however, can save 10% to 20% a year in hot water fuel bills.

Place the water heater near the major hot water users in the home and in a warm place. This will eliminate hot water traveling long distances and cooling down in the pipes.

If the front of the hot water heater is removed for servicing or repair, be sure the insulation is packed back around the elements and the panel is replaced securely. This will eliminate air leakage.

Consider using a timer on an electric heater, especially if no one is home during the day. This will enable the heater to be turned on only when needed, or during the peak periods of operation. Turn off the heater when going away for a weekend or vacation. It takes only three to five hours to totally heat a tank of water from cold tap water.

When selecting a water heater, be sure it is sized properly for your family and needs. A typical family of four requires a 30 gallon gas or oil heater or a 50 gallon electric heater. It should have a thick insulation and a recovery rate of at least 75%, which means the tank will reheat 30 gallons in one hour.

Set the hot water tank thermostat on 120° to 125° instead of 150°. This simple step can save as much as 25% of the annual fuel used to heat water and not add any appreciable inconvenience to the users. This may be too low a setting for some families and, therefore, should be experimented with. Remember, the higher the setting the more fuel will be used.

Another means of reducing the amount of energy used to heat water is to install a heat recovery system on the central air conditioner, heat pump, or fireplace. The unit is a heat exchanger with a circulation pump. The pump uses waste heat from the condenser fan on the air conditioner or heat pump and transfers it to the water tank where it is stored. This acts as a pre-heat or auxiliary heat for conventional units and deserves consideration in those areas where air conditioners are used throughout most of the year and where electric water heaters must be used.

B. ENERGY SAVING TIPS FOR HOT WATER USE

1.) General

The most effective means of conserving energy used for water heating is developing an energy conscious attitude when using hot water. This may require breaking bad habits but it will not place an unnecessary strain on hot water use.

Repair leaky faucets. A 1/32 inch steady stream of water leaking from a hot water faucet could add up to 6,000 gallons wasted in one year, or the equivalent of 200 baths. Water leakage accounts for between 5% and 10% of all residential water consumption. To correct this problem, replace the worn washer. Consider replacing a conventional faucet with a single handle washerless valve faucet. This type faucet uses two smooth ceramic or hard plastic discs instead of a washer and seat, and produces a complete water seal. The washerless valve usually comes with a lifetime guarantee from the manufacturer which makes it maintenance free and attractive.

Replace conventional washers with flow reduction devices in kitchen sinks, shower heads, bathroom lavatories, and utility sinks. These are usually a metal fitting threaded at both ends for easy installation, a plastic "spool" inserted directly into the pipe, or any device that reduces the diameter of the water line. Without these devices, normal flow rates can be up to 12 gallons of water per minute. With them the flow rate can be reduced to as little as 2 gallons of water per minute. A low-flow faucet may require more patience when filling a pail, but at 2 gallons per minute, it will only take 15 seconds to fill 2 quarts, which is not too inconvenient. Do not use flow reducers on faucets which supply dishwashers and clothes washers. These appliances operate on proper amounts of water filling the appliances in a timely manner. Restricting the flow will put an undue strain on the appliance causing breakdown and added expense.

A LITTLE DRIP MEANS A BIG ENERGY WASTE

THINGS YOU NEED:

An 8-ounce glass or plastic graduated measuring cup. A pencil and some paper. A leaky faucet (optional). A clock.

Here's an experiment that shows you how serious the problem is with a leaky faucet. If you have a leaky faucet, use it. Otherwise, adjust your kitchen sink faucet (cold water) to produce a steady drip.

Simply place the measuring cup underneath the dripping faucet, and collect 15-minutes worth of drip. You might, for example, collect 4 ounces of water in 15 minutes.

Now we have to do some arithmetic to find out how much energy was wasted. We'll use the 4-ounce figure in the example below:

Step 1: Multiply the number of ounces of water by 4--this gives you the number of ounces per hour leaking through the faucet.

4 ounces X 4=16 ounces per hour

Step 2: Multiply the answer from Step 1 by 24--this gives the number of ounces per day leaking through the faucet.

16 ounces per hour X 24=384 ounces per day

Step 3: Multiply the answer from Step 2 by 365--this gives the number of ounces per year leaking through the faucet.

384 ounces per day X 365=140,160 ounces per year

Step 2: Multiply the answer from Step 1 by 24--this gives the number of ounces per day leaking through the faucet.

16 ounces per hour X 24=384 ounces per day

Step 3: Multiply the answer from Step 2 by 365--this gives the number of ounces per year leaking through the faucet.

384 ounces per day X 365=140,160 ounces per year

Step 4: Divide the answer from Step 3 by 128--this gives the number of gallons per year leaking through the faucet.

140,160 ounces per year + 128= 1095 gallons per year

That's a lot of water! And it took a lot of energy to make it hot. You can figure out approximately how much oil, or gas, or electricity was wasted by doing the following calculations:

For an oil fired hot water heater: Divide the answer from Step 4 by 110--this gives the approximate number of gallons of oil wasted.

1095 + 110= 9.95 gallons of oil per year.

For a gas-fired hot water heater: Multiply the answer from Step 4 by 0.84--this gives the approximate number of cubic feet of gas.

1095 X 0.84= 920 cubic feet of gas per year.

For an electric hot water heater: Multiply the answer from Step 4 by 0.25--this gives the approximate number of kilowatt-hours of electricity wasted.

1095 X 0.25= 274 kilowatt-hours per year.

2.) Personal Hygiene

Personal hygiene requires large amounts of hot water -- approximately 33% of daily water use. It takes about 30 gallons of water to fill the average bathtub. A shower with a flow rate of 4 gallons of water a minute uses only 20 gallons in 5 minutes. If the shower uses half hot and half cold water, this would be a savings of 5 gallons of hot water by showering instead of bathing. By substituting just one shower for one bath a day, there could be a savings of almost 2,000 gallons of hot water a year. If a flow reducing shower head were installed, cutting the flow rate to 2 gallons of water per minute, this savings could double. In a family of four, a flow reducing shower head which costs $20 and reduces the flow rate to 2 or 3 gallons of water per minute could pay for itself in 3 to 4 years.

Try bathing one after the other so that there will be full utilization of hot water stored in hot water pipes. Limit the shower to five minutes so that as little water as possible will run unnecessarily. Consider taking a shower by wetting the body, turning off the water while soaping, then turning the water back on to rinse. This can be done with some shower controls or with thermostatic mixing valves. These devices automatically mix hot and cold water to a desired temperature so that when it is turned off then back on again for rinsing the temperature will remain the same. This method of showering can save 10% to 40% of the warm water used in showers, but the costs of thermostatic mixing equipment is two to three times

Making water hot takes energy...lots of energy! A typical family uses over 25,000 BTU's of energy each year to heat water for washing everything from hands to dishes. It takes about 300 gallons of oil, or 36,000 cubic feet of natural gas, or 7,500 kilowatt-hours of electricity to do the job.

SHOULD YOU SHOWER OR TAKE A BATH?

THINGS YOU NEED:

Your bathtub. A yardstick. A bar of soap (optional).

Here's a surprising fact: If people who took baths took showers instead, we'd save a lot of energy. This experiment demonstrates what we mean.

Start by taking a bath. Fill your bathtub with water as usual, but before you step in, use your yardstick to measure the depth of water in the tub.

Next, take a shower. Before you begin, though, close the bathtub drain so that the shower water will collect in the tub. When you are finished, measure the depth of water that has collected. Compare this reading with the bath water depth.

You will find that your shower used substantially less water...probably less than half as much! A lot of this water is hot water.

As a rule of thumb, figure that it takes an ounce of oil (or a cubic foot of gas, or 1/4-kilowatt-hour of electricity) to heat a gallon of water. So you can see that showering saves lots of energy.

the price of conventional equipment. This should be taken into consideration before purchase.

When shaving or rinsing items in a sink, fill the sink with water instead of permitting the faucet to run needlessly in an open sink. Do not permit the faucet to run until the water is the desired temperature before plugging the drain. Plug the drain at the beginning thus capturing 3 to 5 gallons of water it could take before hot water reaches a bathtub or sink and the plug is put in.

3.) Kitchen and Laundry

Twenty-five percent of household water is used in the kitchen and laundry. Most of the appliances requiring hot water are located in these two areas.

In the kitchen, use cold water rather than hot to operate a food disposer. Use cold water instead of hot water for rinsing vegetables and preparing food. Use a reduced flow rate device on slow settings for routine rinsing. Do not waste hot water rinsing dishes before putting them in the dishwasher; just scrape them off and put them in the dishwasher. When hand-washing dishes, first soak them in detergent to loosen baked on food and rinse them sparingly. Be sure to use the dishwasher only for full loads. Avoid the extra long, pre-wash and soak cycles on the dishwasher unless absolutely necessary. This can save 3 to 7 gallons of hot water each time. Experiment with shorter cycles and less detergent to save on hot water.

Use cold water for washing clothes whenever possible. With many of the detergents on the market today, this will give as clean a wash as one in hot water. If hot water is used, consider having the hot water tank close to the washer so that heat in the pipes will not escape needlessly.

There are two water saving features built into many of the new automatic washing machines today. One is the water level control. The variable water level control allows the level of the water flowing into the washing machine to be regulated to the appropriate washing need. There is a low level setting for small wash loads, medium, large, and extra large settings or graduatingly larger loads.

Another feature is the suds-saver. This device allows the hot wash water plus detergent to be drained into a stored tub for reuse in the next wash load. This saves heating a second load of wash water. This device features a 20-gallon reservoir which drains into a nearby utility sink; when the second load of wash is put into the washer the tub is filled from this reserve. Though the cost of the device is only $15 to $20, the expense of installing a nearby utility sink may be more expensive than savings realized from reusable hot water.

Sort clothes before washing. This will help determine load sizes and will help group items which require certain water temperatures. Even if a load of clothes must be washed in hot water, it is not necessary to rinse them in hot water. Wash loads consecutively if possible to take advantage of the machine being warm. Other suggestions for saving hot water or using it more efficiently when washing dishes or laundry are given in Module #5.

MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

UNIT 2

WATER CONSERVATION

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Appreciate and explain the amount of cold water used in the home for various activities.

2. Discuss water saving opportunities in the home.

3. Explain the direct and indirect energy use for producing and supplying water for consumer use.

LECTURE

Conservation in all forms is the attitude people are taking today. The consumer is aware of the fuel shortage and unnecessary waste of fossil fuels the facing the nations today. Most people do not consider water as a resource which is in short supply. In most areas of the country, it is not an endangered resource, and it is a renewable resource. However, in some parts of the South where hot, dry climate prevail, water can be a precious commodity. Regardless of the shortage of water to the home, treatment plants required to purify the water before it is used and treat it after it is used, and pumping stations to transport it to and from the home require energy. Most municipal water supply treatment plants are inadequately designed

and overburdened. In most cities and towns, rain, household waste water, and industrial wastes enter the same collection system. Clean rain water becomes contaminated by polluted water. Overload from heavy precipitation floods sewage treatment facilities and allows polluted water to pass directly into rivers and streams.

In 1972, Congress took decisive action to renew water resources by amending the Federal Water Pollution Control Act. Congress set 1983 as the goal date for making the Nation's rivers and lakes clean enough for recreational purposes and help protect sources of drinking water from pollution. The Environmental Protection Agency is managing billions of dollars, in partnership with States and local agencies, to attain this goal. Any measure the consumer can initiate to conserve water at home -- even cold water -- is saving energy indirectly.

The major user of cold water in the home is the toilet, which consumes about 40% of a city's water use. Tank-type toilets normally consume between 5 and 8 gallons of fresh water per flush to sweep away less than a pint of waste. This can be reduced by 3 to 3 1/2 gallons by installing new water saving toilet tanks. They are designed to give full flushing action but reduce the water requirement to about 3 gallons per flush. It may not be economically feasible to replace present fixtures with these new ones since they are fairly expensive. There are some measures which can be taken with a conventional tank,

however. Consider putting bricks or water filled bottles in the tank to displace a certain amount of water. This will allow the tank to fill to its normal level minus the space displaced by the bricks. Another method is to adjust the float so that the tank does not fill to its original level. This does not work well since the tank must build certain pressure from the height of the water line in order to flush properly. One drawback of the measures described is that two flushes may be required to adequately rid the toilet of waste; this would cancel any water saving benefits. Several inexpensive commercial products are available as tank inserts and special flush valves.

Another consideration for toilets is the number of waterless units available on the market. These include compost toilets which compost toilet wastes as well as kitchen scraps. Other units include chemical recirculating toilets, incineration toilets, and gray water sytems for large housing projects. Gray water is defined as recirculated, non-potable water.

Be conservative with outdoor water use. This does not mean stop watering the lawn, but become conscious of ways to better utilize water for this purpose. The impact on energy savings from outdoor watering is not as great as from indoor use because the water does not enter the sewage system. However, many homes use a great deal of water outdoors -- over 200,000 gallons on lawns with automatic sprinklers, for instance. Plant groundcovers such as ivy or iceplant instead of lawn grass

because they take less water. Water in the mornings or late evenings when temperatures are not too high in order to cut down on evaporation. Time watering periods. Locate sprinklers so that they do not spray sidewalks, the house, or run down driveways into the ditch. When washing a car, use a selfclosing nozzle or the hose so that the water can be closed off while soaping the car.

Other water saving tips for both indoor and outdoor use of water include the following.

Do not use garbage disposals. They waste water and energy to operate. They chop solid garbage, mix it with water, and send it to a treatment plant where money and energy is spent to remove the garbage from the water.

Repair dripping faucets; leaks can lose up to 400 gallons of water a day.

Do not leave water running needlessly; turn off water while brushing teeth or shaving.

Install an aerator on the kitchen faucet. This reduces the volume of water flowing, but it is hardly noticeable.

Save laundry rinse water to put on the garden or lawn, in compost, or to wash the car.

In warm weather, wash the car during a rain -- if there is no lightning.

Let the rain water the garden. In a dry spell, give plants one soaking per week in the early morning or late evening.

Collect rain in a barrel or cistern for use around the house.

Reduce flushing toilets whenever possible.

Pre-soak or use a soak cycle when washing heavily soiled clothes. This will avoid a possible second washing.

Install water flow reducers in showers and faucets.

Limit the time in a shower; a 5-minute shower can use up to 60 gallons of water.

Time each shower; unless it can be completed in 4 minutes, a bath might use less water.

For baths, fill the tub only one-fourth full.

Remember the philosophy of using any resource is using it most efficiently. This does not mean doing without; it means getting the most from energy or the resource spent.

MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

UNIT 3

CONSIDER SOLAR WATER HEATING

OBJECTIVES: Upon completion of this unit the student will be able to:

1. Describe the components and operation of a typical solar water heating system.

2. Compute cost for installing and savings realized for using solar energy to heat domestic hot water.

3. Distinguish the characteristics of the two basic kinds of solar water heating systems.

4. Review the facts and considerations necessary before deciding on solar water heating for a specific situation.

LECTURE

Solar water heaters are the most popular uses of solar energy and the most economical at present to install. Tax incentives have been written into law in late 1978 giving the homeowner a maximum income tax credit of $2,200 for installing solar or other renewable energy sources in the home. The President has stated that solar energy would be given more attention in 1979.

Solar hot water heaters are competitive today in areas where electric hot water heaters must be used. Up to 17% of a home's energy consumption is for heating water. It it is heated by

LABORATORY

Solar system installed $1,400
80% solar @ 30 yr. mortgage= $12/month
20% electric water heater = $ 4/month
Total bill for hot water $16/month

electricity at a price of 4¢ per kilowatt-hour, the monthly water heating bill is about $20 to heat 100 gallons of water per day. If a solar system will serve the family with 80% of its hot water need and the conventional electric hot water heater serve the remaining 20%, the monthly bill could be reduced $16/month. Calculating a 30 year mortgage on a $1400. solar system the resulting savings will be $4. per month.

Therefore, a solar hot water system might be considered. If, however, water is heated with natural gas at a price of 17¢ per day, (the average cost for 100 cubic feet of gas which typically heats 100 gallons of water per day) the bill will be about $5.17/month. This is much cheaper than solar. Deregulation of natural gas and escalating prices could change this situation and make solar energy more competitive with natural gas.

A solar water heating system can cost less than $1000 if some of the work is done by the homeowner. Most systems, however, cost between $1800 and $2100 installed. With the annual increase in electricity rates estimated at 4%, a solar water heating system that lasts 20 years and costs $1000 could repay itself in 10 years or less giving "free" hot water for the remainder of the system's life.

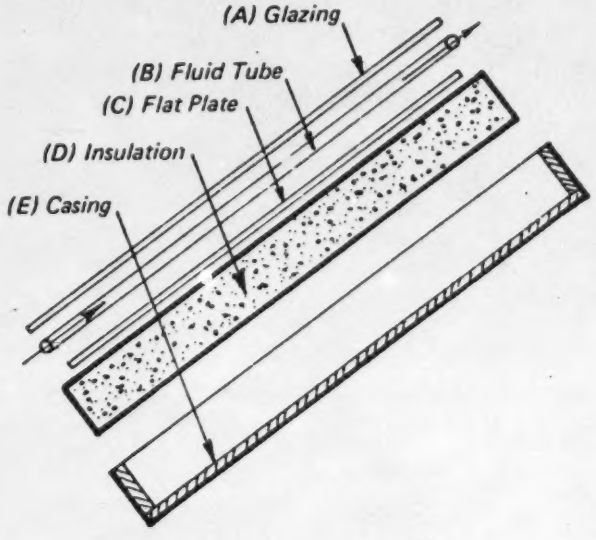
A solar water system does not replace a conventional hot water system; it only supplements it. A solar system is capable of providing water at 115° to 165° depending on the cloud conditions and outside temperature. Therefore, the solar water system might serve as a preheat for conventional water heating systems requiring gas or electricity to bring up the water temperature to the desired temperature.

A. SOLAR ENERGY SYSTEMS

All solar heating systems operate much the same way. The basic parts of the system are the collector, storage, distribution, controls, and auxiliary energy source. The flat-plate collector is the most widely used type for low-temperature water heating. Most collectors use liquid as the heat transfer medium; however, some systems use air for water heating.

Figure 3.1 shows a collector with its following components: glazing (A), usually double-strength glass installed with gaskets or caulking to allow expansion and contraction due to temperature changes; water tubes (B) that are attached above, below or integral to the absorber plate for heat transfer; the absorber plate (C) which usually is metal and is treated with a black paint or dark "selective" coating to improve the plate's ability to absorb heat. The selective finishes are special coatings which absorb most of the sun's rays, thus increasing the efficiency of the collector. The insulation must be able to withstand high temperatures that occur when the collector is operating. The enclosure (E) is a container for the components listed above. Together with the glazing, the enclosure makes the collector weathertight.

FIGURE 3.1
EXPLODED CROSS-SECTION THROUGH A TYPICAL FLAT PLATE SOLAR COLLECTOR



B. KINDS OF SYSTEMS

There are two basic kinds of systems today for most solar water heating: the open system and the closed system.

An open system essentially heats water through the collector and circulates it through a storage tank. This water is used for domestic water consumption just as water from a conventional water heater is used.

Open systems can be either thermosyphon or forced water. The thermosyphon system is the simplest solar water heating system. It combines a flat-plate collector with a storage tank mounted above the collector. The tank is placed high enough for cold water in the downcomer tube to displace by convection the hot water in the collector, thus causing a slow circulation of water. (Figure 3.2)

In a good sunny location, free from shade, a 4X8-foot collector can heat 40-50 gallons of water a day. The piping and storage tank should be well insulated to avoid heat loss.

TYPICAL THERMOSYPHON SOLAR WATER COLLECTOR

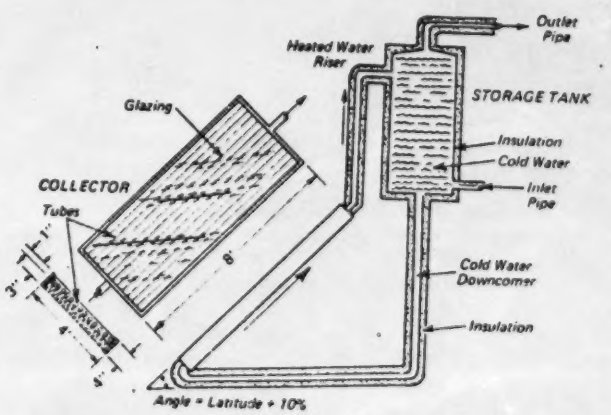


FIGURE 3.2

A forced water system contains the same components as the thermosyphon system with the addition of a pump to force the hot water from the collector to the storage tank. The advantage of this system is that the tank can be located any convenient place, not just above the collector. Controls must also be added to ensure that the water returning to the tank is warmer than the water leaving it. (Figure 3.3)

ROOF MOUNTED PUMPED SOLAR WATER HEATING SYSTEM

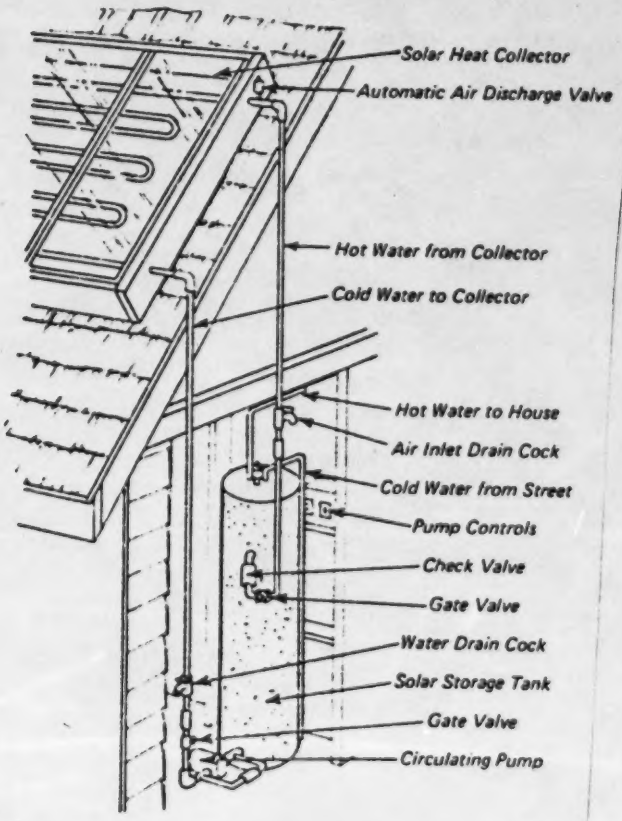


FIGURE 3.3

Both kinds of open systems require a drain-down feature that allows all water to drain out of the collectors in order to prevent freeze damage. In some Texas locations that have mild winters, such as Houston, the danger of freezing may be alleviated in a forced water system by continuing to pump the warm stored water through the collector. Of course, this results in additional heat loss through the collector and requires the use of the back-up heating system.

A closed system includes a heat exchanger and a treated water solution (antifreeze mixed with water) in a closed loop. (Figure 3.4) The treated solution circulates through the collector where it is heated. This solution in turn transfers heat to the home water supply through the heat exchanger. Heat exchangers should be external to the storage tank in order to ensure a double wall between the potentially toxic treated solution and the potable water supply. A closed system can also be thermosyphon or forced water.

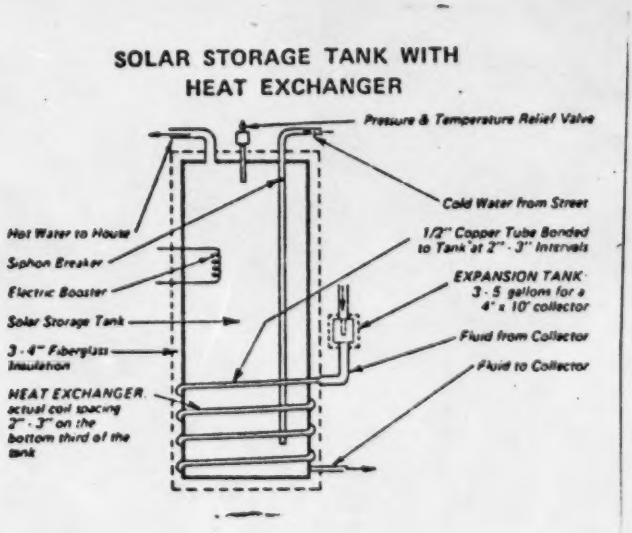

SOLAR STORAGE TANK WITH
HEAT EXCHANGER
Pressure & Temperature Relief Valve
Cold Water from Street
Hot Water to House
Siphon Breaker
Electric Booster
Solar Storage Tank
3-4" Fiberglass Insulation
HEAT EXCHANGER actual coil spacing 2"-3" on the bottom third of the tank
1/2" Copper Tube Bonded to Tank at 2"-3" Intervals
EXPANSION TANK 3-5 gallons for a 4' x 10' collector
Fluid from Collector
Fluid to Collector

FIGURE 3.4

C. THE FINAL DECISION

After reviewing the kinds of solar water heating equipment available, the anticipated life-cycle cost of the systems compared to your fuel costs, and the intended use for the system, consult with a designer, installer, or engineer who has solar experience. Also, keep in mind that the most economical installation is with new structures.

More attention is being given to solar. It is important to weigh all facts before investing in it.

The National Solar Heating and Cooling Information Center makes the following suggestions for consideration when buying solar equipment:

1. Ask for proof that the product will perform as advertised. An independent laboratory or university report should be consulted.

2. Examine the warranty carefully. According to law, the manufacturer must state whether the warranty is full or limited. Ask the seller what financial arrangements, such as an escrow account, have been made to honor the warranties.

3. Solar components should work well together. If the system you are buying is not sold as a single package by one manufacturer, be sure that the seller has experience in choosing compatible components.

4. Be sure you will know specifically who will service the solar system if anything goes wrong. Not just any plumber or handyman will do.

5. Don't try a do-it--yourself kit unless you really have a solar background as a handyman.

6. Check with your local consumer office or Better Business Bureau to determine whether the seller is reputable.

7. If the seller makes verbal claims that are not reflected in the literature handed out, have the claims written down and have the seller sign his name to the statement.

8. If you have what appears to be a legitimate complaint, notify the local district attorney's office.

MODULE #6

HOT WATER HEATING CONSERVATION OPPORTUNITIES

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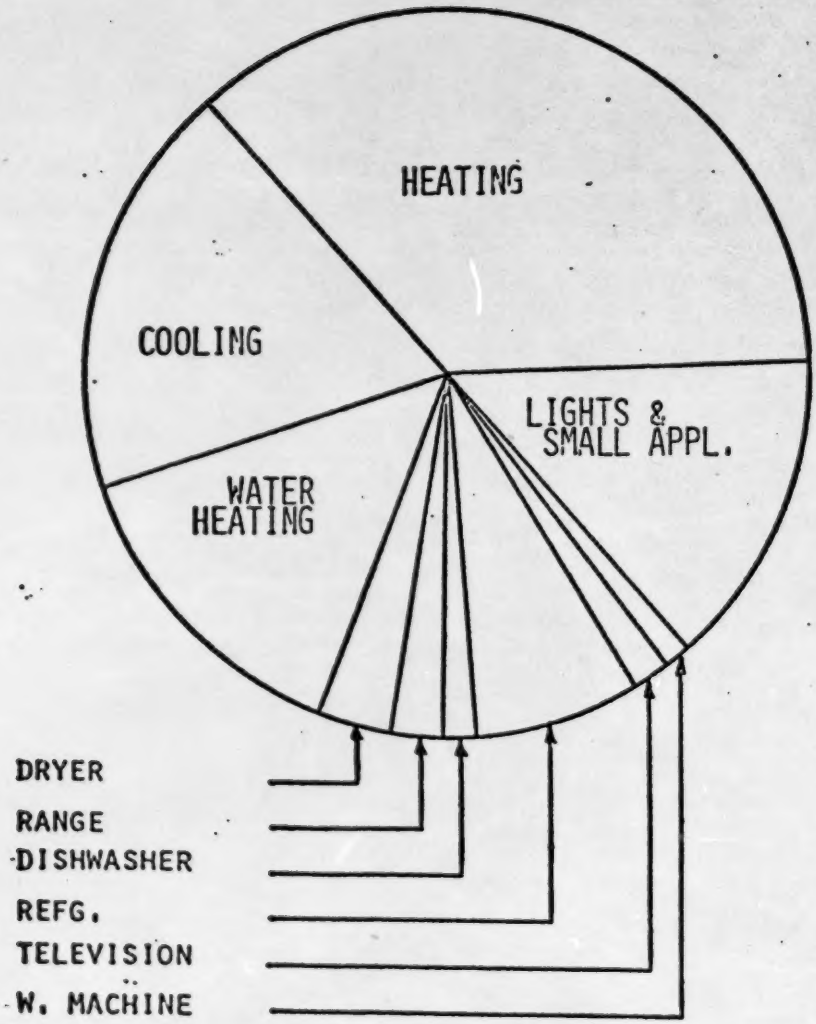
FIGURE 1.1

AVERAGE ANNUAL KWH
BY APPLIANCE



SOURCE: Texas Power and Light Company

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FIGURE 1.2

WATER CONSUMPTION IN A TYPICAL HOME
(FAMILY OF FOUR)

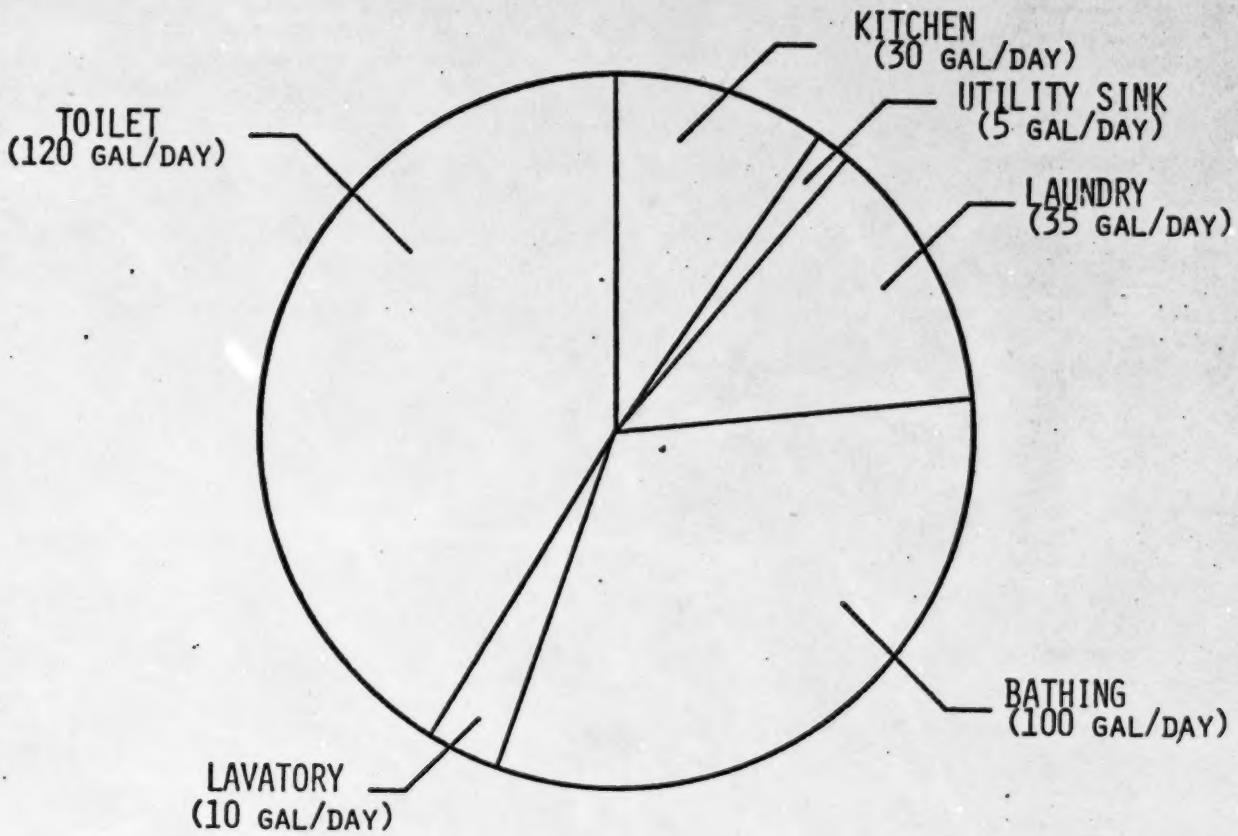

FIGURE 1.3

THE GAS WATER HEATER

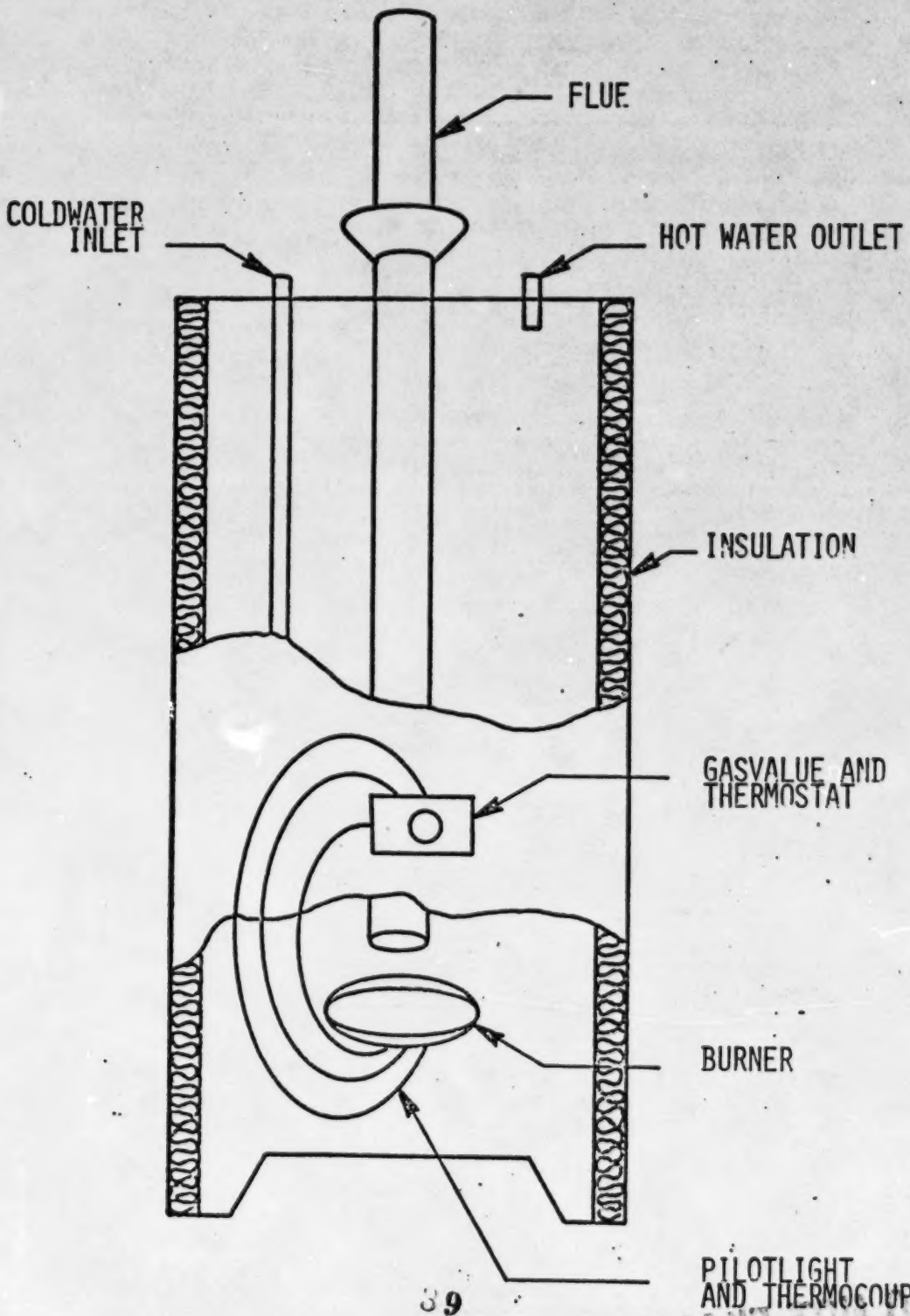

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FIGURE 1.4 THE BELTED-ELEMENT ELECTRIC WATER HEATER

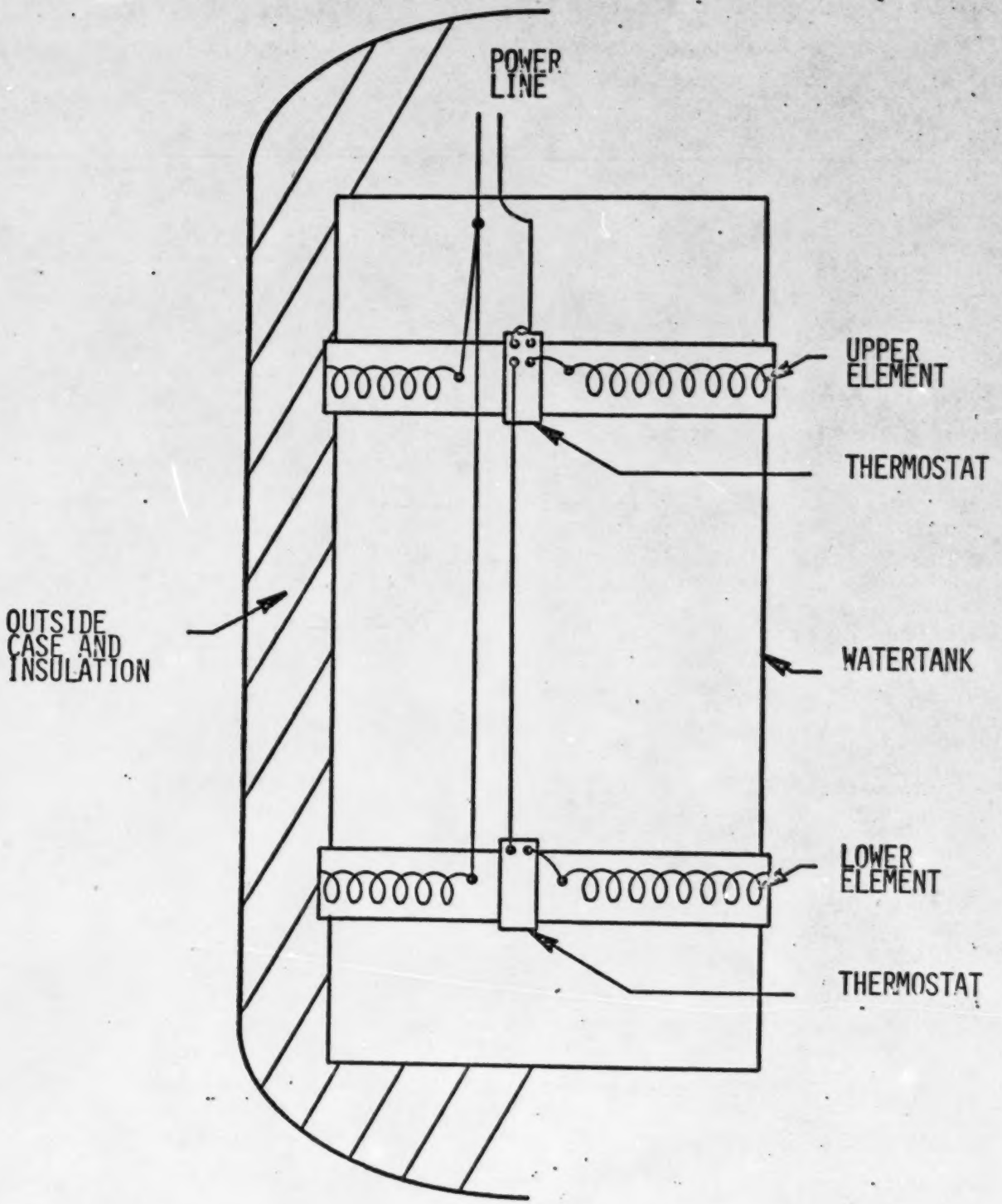

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FIGURE 1.5 THE SUBMERSIBLE-ELEMENT WATER HEATER

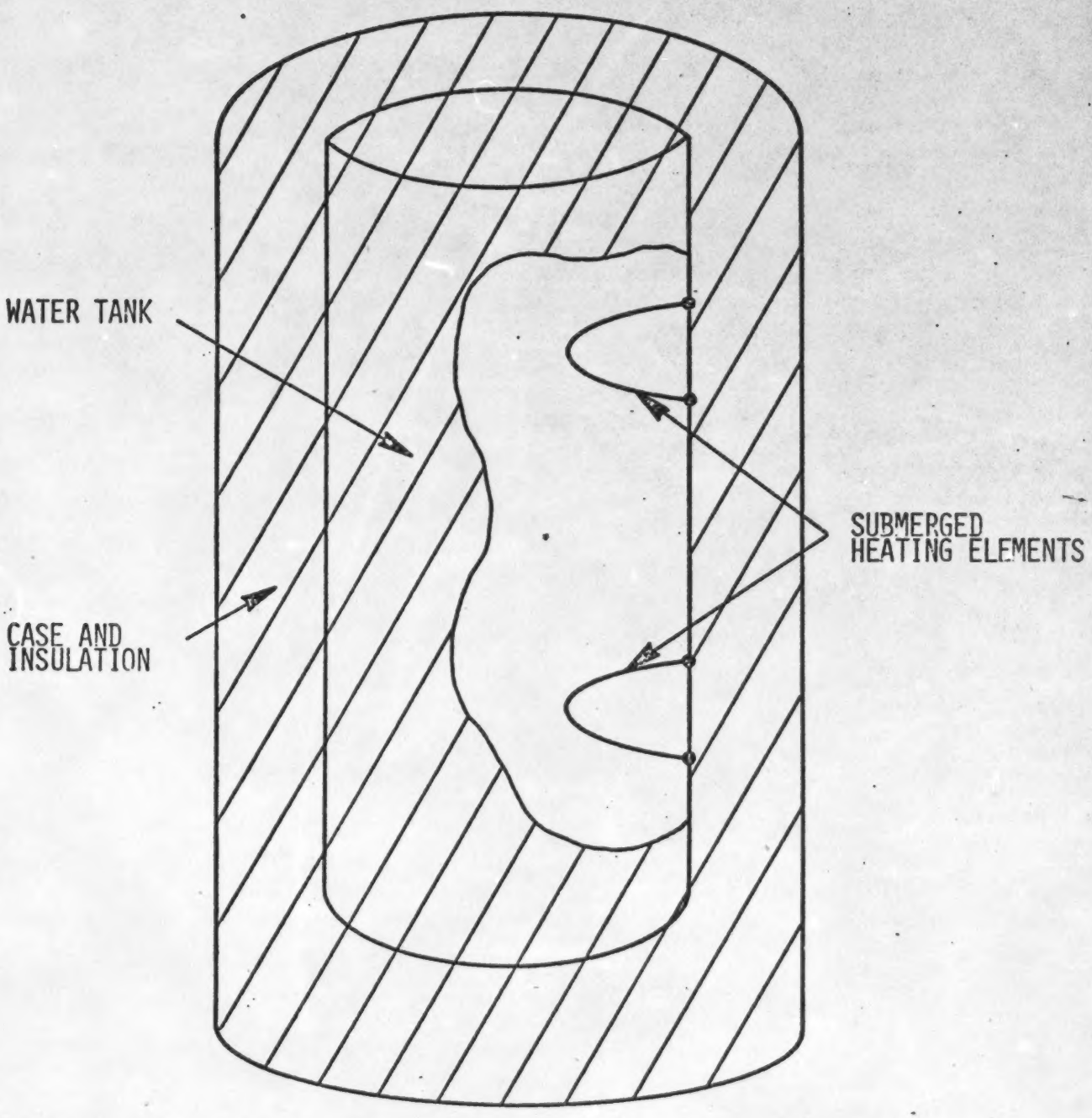

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FIGURE 3.1

EXPLODED CROSS-SECTION THROUGH A
TYPICAL FLAT PLATE SOLAR COLLECTOR

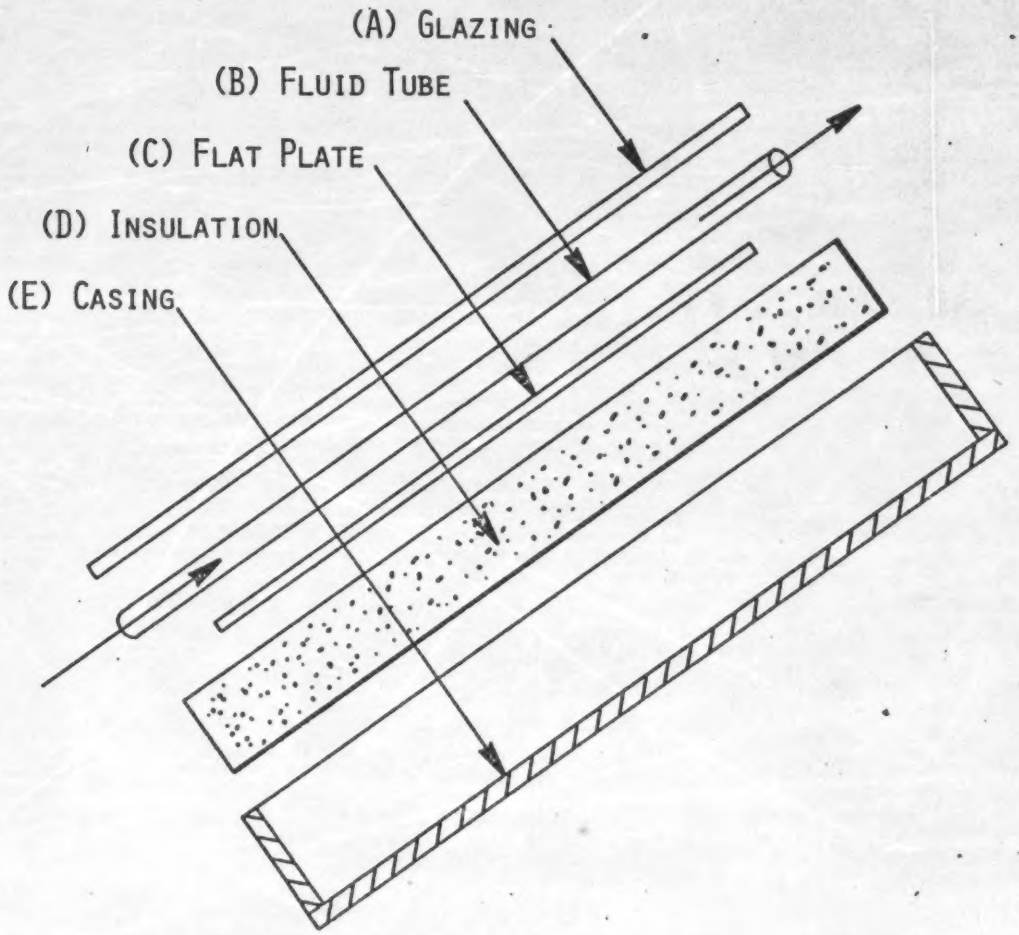

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FIGURE 3.2

TYPICAL THERMOSYPHON
SOLAR WATER COLLECTOR

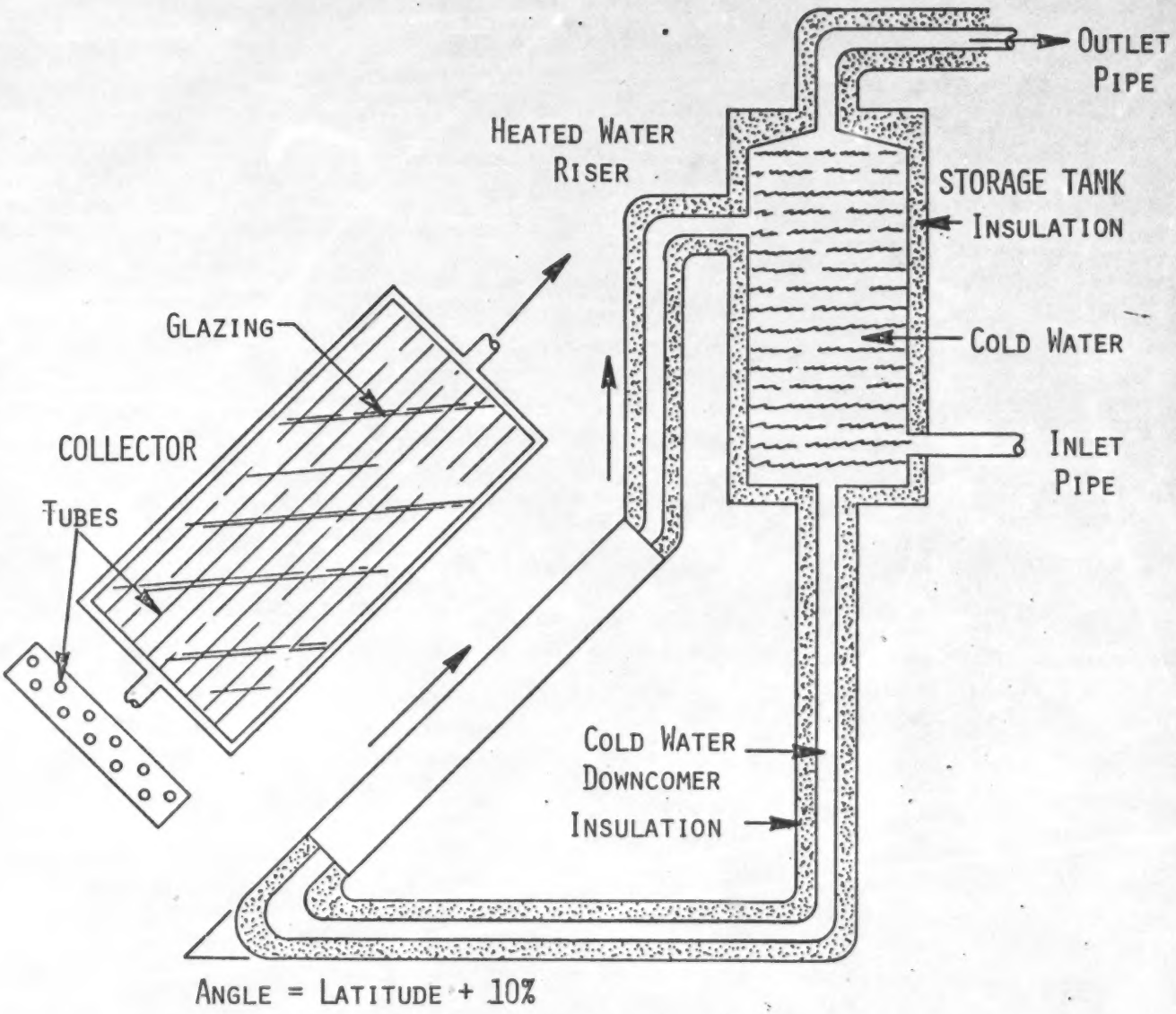

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FIGURE 3.3

ROOF MOUNTED PUMPED SOLAR
WATER HEATING SYSTEM

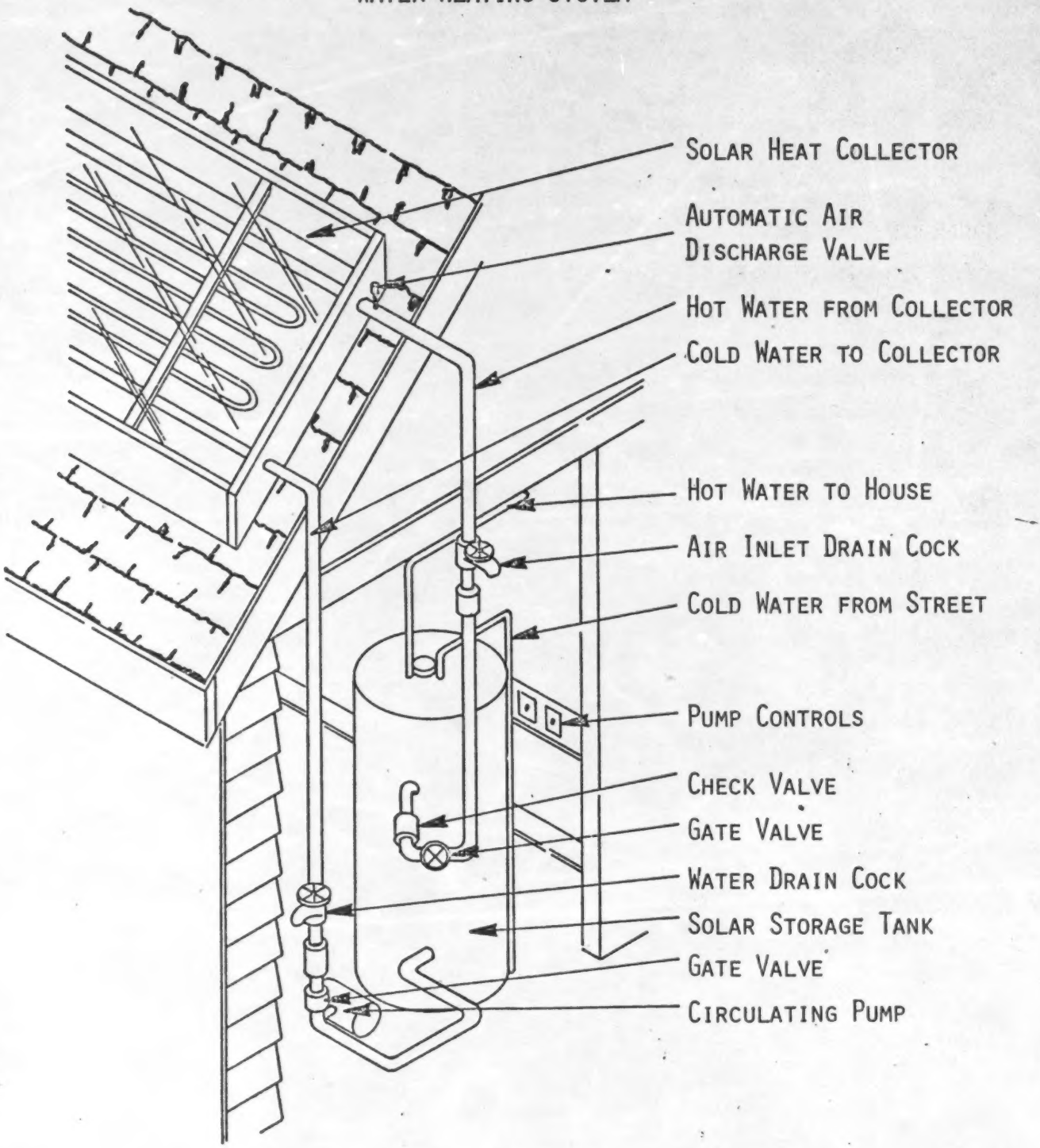

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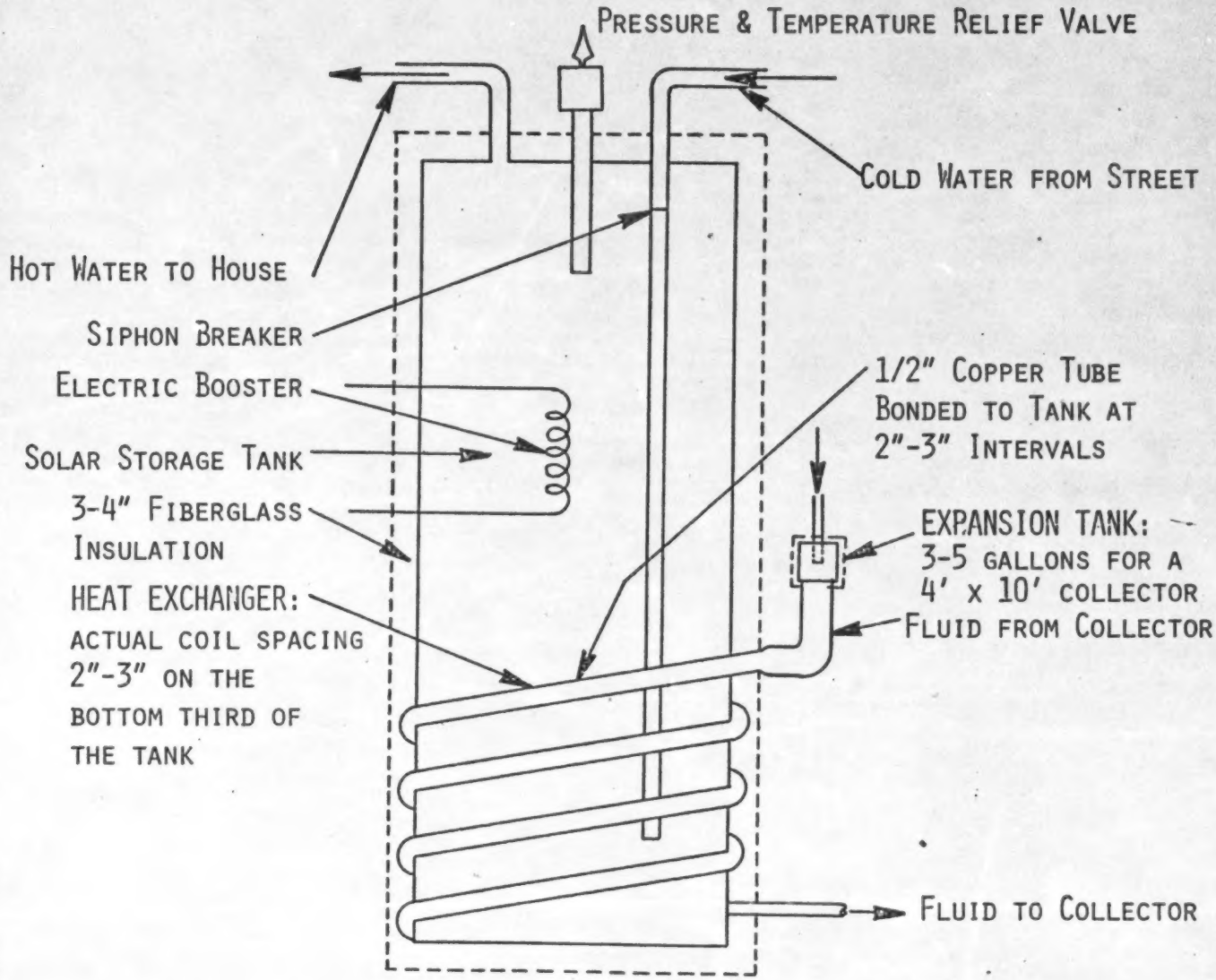
FIGURE 3.4

SOLAR STORAGE TANK WITH
HEAT EXCHANGER


PRESSURE & TEMPERATURE RELIEF VALVE
COLD WATER FROM STREET
HOT WATER TO HOUSE
SIPHON BREAKER
ELECTRIC BOOSTER
SOLAR STORAGE TANK
3-4" FIBERGLASS INSULATION
HEAT EXCHANGER: ACTUAL COIL SPACING 2"-3" ON THE BOTTOM THIRD OF THE TANK
1/2" COPPER TUBE BONDED TO TANK AT 2"-3" INTERVALS
EXPANSION TANK: 3-5 GALLONS FOR A 4' x 10' COLLECTOR
FLUID FROM COLLECTOR
FLUID TO COLLECTOR

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